Crawfish Farming

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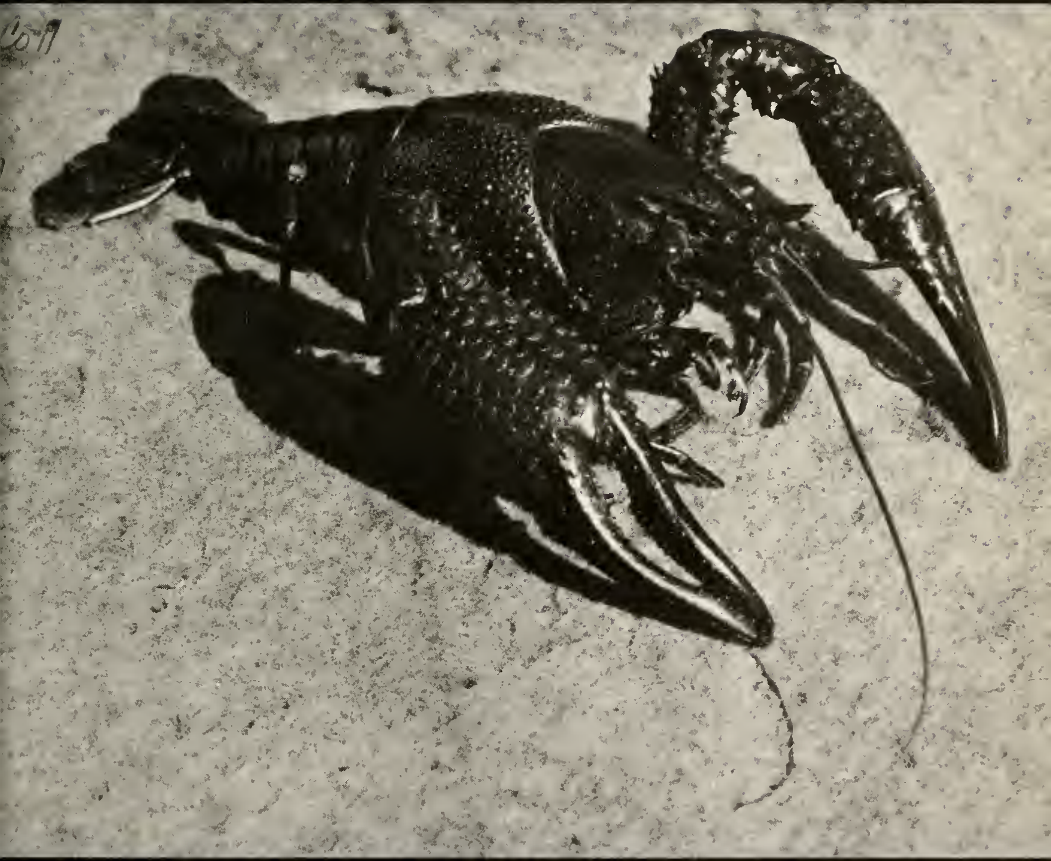

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INTRODUCTION

THE CRAWFISH, which may be called crayfish, crawcrab, crab, stonecrab, crawdad, creekcrab, or other local names, is found in freshwaters on all continents except Africa. There are more than 300 species worldwide, over 100 species in the United States, and 29 known species in Louisiana. In sizes and in colors, the variation is extremely wide; the dwarf crawfish of Louisiana reaches full maturity at about one inch in length, while the Marron crawfish of Australia reaches a length of 16 inches and a maximum weight of four pounds. The world's largest freshwater crawfish is a Tasmanian species which attains a weight of eight pounds. Colors range from light cream to black, with various shades of yellow, blue, red and green.

The detailed life histories and habits of all species of crawfish are far beyond the scope of this article. Some spend their entire lives in underground burrows. Others burrow only during reproductive cycles, or periods of drought. Others do not burrow at all; they occupy puddles, ponds, ditches and various running streams. Crawfish have been recorded in large lakes at depths of 104 feet. The number of young produced annually ranges from about 15 to more than 700 per female.

In some sections of Hawaii, Australia and Japan the crawfish is regarded as a crop pest. In 1930, our own prized red swamp crawfish was exported to Japan to be used as food for bullfrogs. In 1951 Dr. Matsuzo Veno, who was largely responsible for the introduction of the crawfish to Japan, reported that they were present in the vicinity of Osaka at about 2600 pounds per acre and were causing serious damage by eating young rice shoots. The only possible reason that this writer can give for this is that there are no Japanese words for "bisque", "etouffe" or "crawfish boil."

In other parts of the world crawfish are regarded as a food resource. They constitute the primary source of protein for some groups of natives in New Guinea. In the larger cities of Europe they are regarded as gourmet items and are sold for as much as 40 cents each. The supply of crawfish in Europe is periodically depleted by a bacterial disease and in 1964 it was reported that crawfish from Russia were shipped to Stockholm by airplane. Large lake crawfish (*Orconectes, sp.*) are harvested in limited numbers in Wisconsin and boiled in fresh dill and salt, mainly in Scandanavian communities. A large species of crawfish (*Pacificastacus sp.*) is harvested in Oregon and shipped to Los Angeles and other west coast cities as "short lobsters". About $7,000.00 worth of these crawfish are sold annually.

In Louisiana, where gourmets comprise the bulk of the population, the story is quite different. Annually, when the weather becomes reasonably warm in late winter or early spring, the following invariably occurs: Deep in the wild Atchafalaya Basin, hardbitten crawfish trappers run chicken-wire crawfish "cages". In the alligator-grass shallows in the vicinity of Pecan Island, on Lake Pearl near Marksville, and in other places too numerous to mention, professional crawfish trappers ply their trade with cages and lift nets. Other professional trappers harvest crawfish in relatively new operations known as crawfish farms, which will be described in some detail here. Still more crawfish are harvested by sport crawfishermen. Alone or in large groups, Louisianians invade many of the areas previously described plus roadside ditches, rice fields and canals and any other places which harbor crawfish. Crawfish cages, lift nets, and dip nets are usually used, but many crawfish are harvested by small boys and girls with pieces of meat tied to the end of a string.

Crawfish harvesting activities are greatest in the area south of a line running from Lake Charles to Alexandria, east to Marksville then south to Baton Rouge and Lake Pontchartrain. The bulk of the "wild crawfish" comes from the Atchafalaya Basin, where more than six million pounds are harvested in a good year. In addition, there are approximately 14,000 acres of crawfish farms in 14 parishes and about 3,000 acres of new farms expected to be in production for the 1971 season.

CRAWFISH BIOLOGY

The two species cultivated in Louisiana are the red swamp crawfish (*Procambarus clarki*) and the white river crawfish (*Procambarus blandingi acutus*). The red swamp crawfish is found in greater numbers on most farms; however, a few farms have a higher number of white crawfish. The name white "river" crawfish is misleading as this species does not require a "river" type environment. The habits and biological needs of the two species are similar. The reason for the existence of red crawfish in greater numbers in most areas is not fully understood. It is becoming apparent, however, that the white crawfish cannot tolerate extreme conditions of hot water and low dissolved oxygen as well as the red crawfish. Unless otherwise noted, the word "crawfish" will apply to these two species for the remainder of this article.

The life history and biological needs of crawfish are essentially as follows:

Breeding and Burrowing

The peak of the breeding season is believed to occur in open water in late May and early June. At this time male crawfish deposit sperm into an external receptacle on the female. The sperm are held in this receptacle until the eggs are laid in September or early October. This breeding and spawning cycle is possible only in areas where flooding and drying are controlled. When water fluctuates erratically, the spawning is likely to occur at irregular periods.

Shortly after the peak of the breeding season a few female crawfish will "dig in" or burrow. This will occur while open water is still present.

This burrowing usually takes place on the shore near the water's edge. During this time females are exposed to raccoons and wading birds. Aquatic plants in the pond and around the edges will reduce the number of females lost to predators.

Crawfish ponds are usually drained during June. At this time the remainder of the females will dig in. Some male crawfish will occupy burrows with the females. Young crawfish and other males will occupy deep root-holes or simply go down into the soft mud. It is believed that additional breeding takes place in the holes in which male crawfish are present; however, females in burrows without males are able to produce young.

Burrows are usually from 24 to 36 inches deep. Shortly after completion, most burrows are "capped", that is, a compact plug of dirt closes the single entrance hole. The female crawfish remain in the burrows for several months, inactive and undisturbed by predators.

It is possible to distinguish the burrows of red crawfish and white crawfish from those of other species. Burrows of red crawfish will be from 1-1/2 to 3 inches in diameter. These burrows are usually dug straight down or at a very slight angle. White crawfish burrows are essentially the same unless they are dug into a sloping bank. In this case the burrow is dug horizonally into the bank for about 12-14 inches and then more or less straight down.

Other species of crawfish dig burrows much smaller in diameter. Their burrows usually have more than one entrance hole.

Production of Young

The egg laying period begins in September. If the pond is dry, egg laying will occur in the burrows. Eggs are laid and simultaneously fertilized by the sperm held in the receptable of the female. They are held in place on the underside of the female's tail by a sticky substance called glair.

The red crawfish eggs hatch in 14 to 21 days while the white crawfish require 3-8 additional days for hatching. Not all eggs hatch, but the red crawfish average about 400 young (maximum 700) and the white crawfish somewhat less. These young crawfish are less than ½ inches long and about as big around as a pencil lead.

The peak of the hatching period is in October. At this time ponds should be flooded as an abundance of water is a critical requirement. The young crawfish, which have been clinging to the females, are released by the females. If plenty of water is present, the young, which are "free swimmers", will immediately begin to feed and grow. If water is not present, some young will be released in the burrows. Due to lack of food and crowding, these young will not grow. Other females will attempt to crawl overland and will either die from dehydration or be captured by predators. Ample water, therefore, is a necessity for a good crop.

Food Habits

Crawfish will eat dead and living plant and animal matter. They prefer fresh meat and are not attracted to bait that is in advanced stages of decay. As they are not active predators, they are unable to capture the more mobile water organisms. About 20 percent of the diet consists of worms, larvae, and other relatively immobile animal material. The remainder consists of vegetation, but it is difficult to establish a definite line between animal and vegetable material in aquatic situations. Vegetative material, particularly in decay, contains large amounts of microscopic animals. The protein content of vegetation increases considerably in the decaying process due to this increase in available animal material. It is probable that crawfish, particularly the young, are attracted to vegetation that has this higher protein content. For large crawfish, green vegetation is a necessity as it contains carrotin, which produces the bright yellow "fat" or liver.

Other Habits

After the October flooding, young crawfish will occupy the shallow portions of the pond. They are usually found around the edge of the pond in dense grass or weeds. The intermediate sizes, 1-½ to 3 inches long, will occupy deeper water along with adult crawfish.

Young and intermediate crawfish are fairly active, even when water temperatures are in the 50-60 degree Fahrenheit range. It is believed that all sizes of crawfish will grow better when temperatures are above 60 degrees. Best temperatures are thought to be in the 70-85 degree range. As long as water conditions are favorable, crawfish will continue to feed and grow. If water temperatures are in the optimum range and adequate food is present, young crawfish may reach market size in 60-90 days. Water conditions are not always so favorable. Water temperatures below 45 degrees will drastically reduce crawfish activity and growth.

Decaying material in the water may cause a shortage of dissolved oxygen. In this case crawfish will come to the surface and breathe air. They can be seen on limbs and vines or clinging to weeds and clumps of grass at the surface of the water. Crawfish, though not normally killed by low oxygen conditions, will cease feeding and growth is reduced.

Predators

Fish are the most serious predators in crawfish ponds flooded by surface water. The critical period occurs immediately after the young are hatched in October. Small fish (sunfish, catfish, etc.) can easily capture the small crawfish. One green sunfish, in the three inch range, can consume 16 post-larval crawfish in a 24 hour period.

Grackles (chocks, crow blackbirds), bullfrogs, raccoons, mink, and wading birds are also predators. Ducks are not serious predators, but cause problems which will be discussed in a later section.

Heavy cover will reduce the number of crawfish lost to these predators. Dense beds of grass and weeds provide both cover and food. Some of the better types of vegetation for cover and food are those not easily killed by standing water. The best types are those that will thrive either in standing water or during the period when the pond is dry. Examples are: alligator weed or water primrose.

This discussion does not include all that is known about crawfish biology. It does deal with the phases that can be partially controlled by the crawfish farmer.

POND LOCATION AND CONSTRUCTION

Crawfish ponds fall generally into 3 types.

1. Rice fields. Crawfish are grown in rotation with rice. As these fields are already established, it is not necessary to discuss construction in detail. Since rice is normally grown in about 6 inches of water and a crawfish pond must hold 12-30 inches, some rice/crawfish farmers have found it necessary to raise their levees to safely hold this greater depth.

2. Open ponds. These are similar to rice fields, but the only crop is crawfish. Crawfish farming procedures may be followed in open ponds without regard for rice or other crops.

3. Wooded, or swampland ponds. These differ from open

ponds in having varied amounts of shrubs and trees. This type pond is discussed separately because it presents problems not encountered in the open pond.

Before building a crawfish pond, consideration must be given to choosing a suitable pond site. Land slope, soil, water supply, and types of vegetation present must be considered.

Choosing a Pond Site

The land chosen sould be relatively flat. Water depths of over 30 inches are undesirable. When the high ground in the pond is covered by 12 inches of water, depths of over 30 inches should not occur in more than 25 percent of the remaining pond area. Ideally, the water depths throughout the pond should range from 12 to about 30 inches. If the slope of the land will not allow these water depths, costly inside levees must be built.

An adequate supply of water must be available near the pond site. Many farms use water from natural streams or canals. Stagnant lakes or borrow pits are not recommended. The prospective crawfish farmer should try to determine the general quality of water if a stream or canal is to be used as a water source. The Water Pollution Control Section of this Commission may have a record of water checks taken from the proposed water source. Local residents or fishermen may provide a history of recent fish kills. If other established crawfish farmers are using the source, they should also be consulted.

Types of vegetation present may have a decided effect on the success of the pond. Dense stands of water hyacinth, cattail and other large, tough plants are undesirable. These plants do not furnish a significant amount of food for crawfish. They prevent free access to the pond and are a hindrance to fishermen. The cost of killing undesirable plants is high and must be considered in initial construction and possible future maintenance costs. Water hyacinths and cattail may persist and present a continuing problem.

Densely wooded areas make poor crawfish ponds. This is particularly true where many hardwoods are present. Dense shrubbery and trees hinder fishing, prevent growth of desirable plants, add leaves which decay and cause oxygen problems, and keep water temperatures down at critical periods. Clearing of such trees and underbrush will increase construction costs.

Building the Pond

Levee construction will not be discussed in detail. Many agencies and individuals are able to assist in this respect. County agents, Soil Conservation Service personnel and various heavy equipment contractors are available for advice and assistance. Generally the following points should be kept in mind in constructing a new crawfish pond:

1. Levees should be wide enough to permit access to vehicles. This will facilitate levee repairs and pumping operations and generally make the pond more accessible.

2. Levees should be high enough to prevent nearby streams from overflowing into the pond during periods of high water.

3. Inside levees should be constructed to the extent that no portion of the pond is larger than 300 acres. Water control, generally, can be maintained in large ponds when portions are kept to this size. When bad water conditions exist, these smaller portions will allow better mixing and more rapid "flushing out" of the pond. Ideally, each section of the pond should be equipped with a separate pump.

4. Logs and large limbs should not be incorporated into the levee fill. They will rot and may cause breaks in the levees.

5. Adequate screened drains must be provided to prevent the crawfish from leaving the pond. Screens should be of ½ inch mesh or smaller and the drain should be of sufficient size to allow complete draining of the pond in 30 days. Drains should be located as far from the pump as possible. This will allow better mixing of fresh water in the pond. Drains located close to inflows carry out much of the fresh water before it can mix. In this situation more pumping time is required to clear up water problems.

6. Large open ponds have encountered problems of erosion on levees. Fishermen complain that these ponds are hard to fish because of high winds. One solution to this problem would be buffer levees. If wooded areas are to be cleared, strips of trees or brush could be left standing as windbreaks. In either case these barriers should run in an east-west direction, at right angles to the prevailing winds.

It is not essential that the land be absolutely level; small "humps" which will appear when the water is gradually let down will afford places for the female crawfish to dig in.

WATER QUALITY

The two species of crawfish commonly grown have a wide tolerance to concentrations of the elements which usually exist in water. The exact water composition for maximum growth has not been determined. Viosca stated that sodium bicarbonate and iron were harmful to crawfish and that calcium and a little salt were beneficial, but the specific amounts of these elements or compounds were not given.

Crawfish in acid waters tend to have thinner shells. The writer has found high populations of market size crawfish in waters ranging from a pH of 5.8 (slightly acid) to 8.2 (alkaline).

Crawfish have been found dead in traps when they were left for periods of 24 hours or more at a dissolved oxygen concentration of less than 1.5 parts per million.

The writer has determined that crawfish will tolerate iron at 4 parts per million. One very good pond was found to contain iron at 6 parts per million, but iron dissipates rapidly if the water runs for some distance before entering the pond proper. Water checks at one well contained iron at 3 parts per million and, after running down a canal for 150 feet, contained .4 parts per million. It seems advisable to adopt this practice when wells contain a high amount of iron.

Fertilization of the water for crawfish is a controversial subject. Invariably, the most successful crawfish farmers realize the need for obtaining dense stands of vegetation during the months when the pond is dry. A farm fish pond is heavily fertilized to make the pond "bloom" and exclude the sun's rays, which will kill a substantial amount of vegetation. This fertilization does create a large number of small water animals. Crawfish are unable to catch these in substantial amounts, even though they may be preferred over certain types of plant food. Examinations of more than 1,000 stomachs of crawfish from many areas indicate that the bulk of the food consists of vegetation. With this in mind, the most logical approach to the fertilization problem would be to determine the best types of plants, and if fertilization is necessary, to apply it to these plants during the dry months. Many ponds flooded by surface water are plagued by dense algae blooms (green scum). This indicates that the water is *too* fertile. Farm fertilizers and other wastes in surface water, coupled with rich alluvial soil, indicate that basic fertilizer is not necessary. Further research is needed to determine if certain elements could be added to increase production.

It is necessary to pump water periodically for restoring water levels or to "flush out" a pond. A deep well is the best source, but many farmers pump from various bayous and canals. The danger of this lies in the fact that many insecticides, herbicides, petroleum compounds and other substances will infiltrate some of these waters.

The effects of many insecticides, herbicides and other substances on crawfish are still unknown. Pryethrum, commercial creosote stock dips, coal tar creosote, orthodichlorobenzene, sodium cyanide, turpentine, ortho cresole, cresylic acid, miscible pine oil, nicotine, carbon bisulphide, phenothiazine and calcium cyanamid are toxic to crawfish and have been used to remove crop-destroying crawfish populations.

Methyl parathion is extremely toxic to red swamp crawfish at treatment rates exceeding ¼ pound per acre. Endrin, DDT, Sevin, Bidrin, Didrom and phosphamidon are also toxic in that order.

The propynl compounds (Stamm, Rogue, Propynl-3) used on rice at one pound per acre, have not proved harmful to crawfish in several areas observed. If this treatment is exceeded in any part of the field, damage may result.

The use of treated rice seeds in a rice/crawfish operation is a somewhat controversial subject. Some rice-crawfish farmers have claimed that treated seeds have caused complete disappearance of crawfish populations, although experiments have shown that seeds treated at the proper rate are not harmful. The L.S.U. Rice Experiment Station now recommends that treated seeds not be used if crawfish crops are desired. Crawfish should not be stocked less than 60 days after the last application of treated rice seed.

Many crawfish ponds are located in the immediate vicinity of intensive farming operations. The crawfish farmer should take the following steps to reduce the possibility of a heavy kill of crawfish by insecticides or herbicides:

1. Inform the field crop farmer of the general nature of a crawfish operation.

2. Assure that crop-dusting pilots know the location of the crawfish pond. This will reduce the possibility of accidental or drift contamination.

3. Know when spraying is being conducted. This is particularly important when the pond is being flooded in late August or early September. Late spraying is sometimes conducted during the period. Some of the material may fall directly into the water source and be pumped directly into the pond. Pumping should be stopped until a fisheries biologist or a representative of the Water Pollution Section can check the water.

The same procedures should be followed for other types of pollution. Names and addresses of biologists and others to contact appear at the end of the article.

Source water should be checked at 24 hour intervals when pumping. If a fish kill is observed, pumping should be discontinued until the above procedure has been followed.

There is increased interest in crawfish farming in the marsh area in the southern most part of Louisiana.

Experiments conducted in the marsh over a period of two years have established that crawfish will tolerate salt at the amounts given below:

Period	*Salinity (Parts per Thousand)*
Egg laying and hatching September, October, November	4-8
Winter growth Dec. through March	4-7
Spring growth and breeding April through June	3-8

The above tolerances are for red crawfish only. The changes in salinity were relatively gradual. Rapid changes in salinity, particularly during the egg laying and hatching period, would probably result in decreased crawfish production.

SOIL

The primary consideration for soil for crawfish ponds is that it will hold water. Wild crawfish are found and crawfish are grown in most of the soil types found south of a line running from Lake Charles northeast to Alexandria and then southeast to Marksville and down to Lake Pontchartrain. The pattern of best soil type related to crawfish growth has not become entirely evident. According to Mr. Carl Thomas, of the U. S. Soil Conservation Service, resident populations of red swamp crawfish may occur in rice fields with Baldwin, Crowley, Harris, Iberia, Portland and Sharkey soils.

A number of the larger, non-rice field farms are located in the Henderson-Catahoula-Cecelia-Breaux Bridge area which lies in a belt of older alluvial soils of the Baldwin and Iberia types. Surface soils of the Baldwin type are medium to slightly acid and the black or silty clay Iberia soils are neutral to alkaline. Soils of this association contain moderate amounts of organic matter and are moderately well supplied with mineral nutrients.

Harris soils (peats, mucks and clays) in the Pecan Island-White Lake area range from acid to alkaline in reaction and are high in organic matter.

Acadia Parish has mostly rice fields farms. Generally, the Crowley-Midland soils are slightly acid to neutral and contain low amounts of available phosphorus and moderate amounts of other plant nutrients. Most of the crawfish farms in Vermilion Parish are also of the Crowley-Midland types.

Lake Pearl, with its associated drainage basin, is in the recent alluvial soils of the Red River. Soils of the Yahola-Norwood-Miller-Perry types constitute most of this area. These soils contain moderate amounts of organic matter and high amounts of mineral nutrients.

This soil complex extends in a band about 15 miles wide, mainly on the west side of Red River, extending to the Arkansas border. This area offers distinct possibilities for crawfish farms.

POND MANAGEMENT

Proper pond location and construction will reduce management problems. The most common problems are broken levees, nearby streams overflowing levees during periods of high water, and bad or "blackwater" conditions caused by decaying material. These are problems that will persist in improperly located and poorly constructed ponds.

The pond manager must establish, maintain and harvest the highest possible number of market size crawfish as early as possible during a season. This requires stocking of "seeding" crawfish, proper control of water and vegetation, and intensive harvesting.

Stocking

The most economical time to stock crawfish is late May or June. Crawfish get "tough" at this time and prices are reduced. Some females are at least partly bred by this time. The ratio of males to females will be about even. The new pond should be flooded for at least two weeks prior to stocking. Crawfish held in coolers overnight should not be accepted. The crawfish should be fairly large, about 12-18 to the pound. A partial list of dealers appears at the end of this article.

The crawfish will be received from the dealer packed in open mesh sacks and should remain in these sacks during transport to the pond. They should be kept cool and damp and put in the pond as soon as possible. Initial loss from predators will be reduced if the crawfish are released in dense grass or weed beds. If little cover is present, the crawfish should be released in the deepest water, far away from the edge of the pond.

Stocking rates will vary with existing conditions in the pond. Some ponds are constructed in areas where crawfish were present. In this case 20-25 pounds per acre may be stocked if some cover is present. If no crawfish are present, a densely vegetated pond should be stocked with 40-45 pounds per acre.

Densely wooded ponds and open ponds with sparse cover should be stocked at 45-60 pounds per acre.

Open ponds with little cover should be stocked at 60-100 pounds per acre.

The average sack of crawfish bought in Louisiana will usually contain at least 80 percent red crawfish. A few *farms* have a high ratio of white crawfish. Early season catches from some Atchafalaya Basin areas will occasionally contain mostly white crawfish. If the crawfish to be stocked are mostly white crawfish, the farmer should add 25 percent to the above rates. Most dealers and biologists are able to identify the two species.

Yields of crawfish cannot be directly related to the numbers of crawfish stocked. The condition of the stocked crawfish, how well they adapt to conditions in the pond, and the numbers lost to predators will be the deciding factors.

Further stocking is not necessary in most ponds. There should be enough adult crawfish present after harvest to produce further crops.

Another method of stocking and establishing a crawfish pond is currently being tried by a new farmer. He stocked a 10 acre open pond, with fair cover, at about 35 pounds to the acre. Crawfish had never been grown in this locality. He has obtained a very high production of young crawfish and now plans to expand the operation to 240 acres. The 10 acre pond will furnish enough stocking crawfish for about ½ of the larger operation. This procedure is recommended for operations outside of the area where crawfish are normally farmed.

Water Control

The crawfish farmer must compete with dealers who buy "wild crop" crawfish. If rainfall is well below average during September-November, the wild crop harvest will be late. The farmer should make sure that his pond is flooded by the 1st. of October. Failure to do this may cause the farmer's crop to come in at the same time as the wild crop. Early crawfish bring the highest prices and large harvests of wild crawfish quickly bring prices down.

It was previously felt that October and November water level could be kept about 6 inches below the recommended levels to allow more rapid growth of young crawfish. This practice cuts down on fishing areas and causes more loss from predators in many ponds. It is now recommended that the pond be completely filled with the first flooding.

During the remainder of the harvesting season, the water level should be kept fairly stable. It will be necessary to restore water lost by evaporation. Low oxygen or "blackwater" conditions may develop, at which time it will be necessary to "flush out" the pond with fresh water. If water temperatures are reasonably stable, any sharp reduction in the harvest can usually be attributed to low oxygen or other conditions brought on by decaying material. Persistent pumping of fresh water usually clears up these conditions.

It is not usually necessary to pump during the colder months, or when the water temperature is below 70 degrees. The importance of observing the water source during pumping operations cannot be overstressed. Pumping should be stopped immediately when fish kills are observed, when fish are apparently in distress, or when there is any unusual odor or color in the water.

The pond is slowly drained at the end of the harvesting season. This should occur before the end of June. A 300 acre pond should be drained in 3-4 weeks. This slow draining will allow the young crawfish to find soft mud in which to survive the summer. It will also give adults time to find suitable burrowing areas. Quick draining will expose many crawfish to predators.

Drying out crawfish ponds permits a new growth of vegetation, forces female crawfish to burrow for better protection and reduces the number of fish and other aquatic predators.

Vegetation

Crawfish will eat a wide variety of plants. Generally, the more tender plants are the most desirable, particularly for young crawfish. The writer and other observers have established that crawfish will eat non-aquatic plants such as white clover, alfalfa, Bermuda grass, sorghum and various millets. They will also eat aquatic plants such as water primrose, smartweeds, alligator grass, duckweeds and many others.

Some farmers have planted millets and sorghum for crawfish and have claimed increased yields. It is not known if these plantings were solely responsible for the increased harvest of crawfish. Research is being conducted on supplemental plantings, but little information is currently available.

During the past two years many crawfish farmers have planted various grains in ponds to attract ducks. It has become apparent that cultivating grain in all or a large portion of the pond is detrimental to crawfish. Large numbers of ducks grossly overfertilize ponds and cause heavy growths of cold water algae. This algae causes a bottom condition of high hydrogen sulfide and low dissolved oxygen. Young (post-larval) crawfish are either suffocated on the bottom or become entangled in the algae. If the pond is completely cultivated, the problem is compounded by the lack of aquatic plants to absorb some of the excess fertilizer. The most serious algae problems are encountered in ponds with rich surface water, rich alluvial land, lack of true aquatic plants and an abundance of ducks. Any two of these factors will probably cause some algae growth.

It is now recommended that ponds needing vegetation be planted with untreated waste rice or other grains late enough to insure that no seed heads are present at flooding time.

Proper water control and the elimination of large, undesirable plants are the most effective ways of assuring adequate vegetation. The Hyacinth Control Section of this Commission can give detailed advice on the elimination of hyacinths and aquatic plants other than trees. This section gives active aid only to public water projects and cannot perform actual work in private ponds.

Trees and underbrush can be eliminated mainly by cutting and/or clearing by bulldozer. Cypress and willow, if not too dense, can be left standing. Buttonbush and broadleaf trees such as ash, maple, oak and cottonwood should be eliminated. Logs and other debris should be stacked and burned.

Large aquatic plants, trees and underbrush also keep water temperatures down during winter harvesting, when crawfish prices are highest. This results in a catch substantially lower than in open ponds.

A brief summary of specific plants commonly found in crawfish ponds is as follows:

1. Mat algae (green scum). Primarily winter plants. Long threadlike plants which form large floating mats. Usually killed off by hot weather in March or April. Hindrance to crawfishermen by fouling traps. Will cause low oxygen condition when killed by warm weather. Can be partly removed by pumping and "floating out" of clear areas in open ponds to allow fishing access.

As previously mentioned, heavy "blooms" or mats of algae are caused by overfertile water. Adequate vegetation which will grow in the water will reduce this problem. No grain should be planted early to attract ducks. In some cases pump intakes can be raised nearer the surface as bottom water is more fertile than top water in slow-moving streams.

2. Cattail. Common, persistent, tough emergent plant. Hinders fishing and shades out desirable plants. Early control is imperative. Small scattered growth can be pulled up or chemically treated. Contact Hyacinth Control Section. If out of hand, affected areas of the pond must be plowed at least 5 inches deep immediately after drying to partly control and allow growth of smaller desirable plants.

3. Bull-tongue, black-rush, arrowhead and similar plants. These plants are usually present, but seldom present a problem when ponds are dried annually. Treat same as cattail.

4. Alligator-grass (weed). Excellent food and cover plant for crawfish. Can be seeded into a pond by raking it out of canals, ditches or other bodies of standing water and scattering it in the pond during pond drawdown in June or July. This plant may grow too thick, keep water temperatures down, and hinder fishing. Boat trails may be disked and raked during the dry season or cattle may be grazed on the pond until it is evident that the plant is sufficiently retarded.

Criss-crossed boat or fishing trails 8-12 feet wide over 30-40 percent of the total pond area can be cleared. This can also be done by spraying with 2-4-D immediately after drying with a ground rig. The amount of 2-4-D used should not exceed 3 pounds per acre of total pond area.

5. Water primrose. Believed now to be better than alligator-grass, especially during and immediately following extremely cold winters. Plant is more tolerant to freezing weather than alligator-grass; furnishes food and cover in late winter and early spring. Mixture of alligator grass and water primrose seems ideal.

6. Pondweed (smartweed). Fair food and cover plant. Grows as volunteer plant in most ponds.

Livestock should not be grazed on the crawfish pond during the period when the pond is dry with the exception mentioned under alligator-grass above.

Harvesting

Any discussion of harvesting crawfish must be preceded by a brief discussion of crawfish population dynamics:

Crawfish are hatched in ponds mainly in late September and early October. With adequate feed and mild water temperatures the earliest hatched young will attain market size (3 inches) *in open ponds* by mid-December.

While these young are growing, many adult crawfish (holdovers) are present. These crawfish should be harvested in November and December. This provides more food and space for young crawfish. Many of these adults will reach the end of their life spans during the winter months if not harvested during this period.

If water temperatures go below 60 degrees in December, there may be a "gap" in harvesting—most of the adults have been caught and the young have not reached market size. This is particularly true in wooded ponds where shaded water will cool quicker.

Harvesting is spotty in January and February—the 50 degree water temperature mark is critical. Normally crawfish are reasonably active above 50 degrees and inactive below this point.

Intensive harvesting usually begins in open ponds in March or early April. Wooded ponds are usually about one month later due to lower water temperatures. Unusually cold weather in March and early April (1970, for example), can result in a complete failure of the October hatched young to reach market size for the season.

Crawfish are harvested by means of lift or "drop" nets or by the use of funnel traps. Most of the ricefield ponds are harvested with nets and the non-ricefield ponds with traps. Rice fields are usually more accessible and have uniform depths, which facilitates fishing with nets. The most common bait used in nets is beef pancreas or "melt."

Wild crawfish areas and the larger wooded ponds are fished with ¾ inch mesh chickenwire traps. The ¾ inch mesh traps are easily and economically built, can be pressed flat for hauling and retain only market size crawfish. Most experienced fishermen build traps 30 or more inches long.

Low oxygen conditions cause crawfish to die in the traps. A trap 30-36 inches long can be propped up at an angle so that a small portion is above the surface of the water. Crawfish can stay alive by coming to the surface to breathe. Various baits are used. The most common is fish heads, followed closely by cut shad. Cut carp, mullet, cottonseed cake, soybean cake, perforated cans of dog food and many others are also used.

Most experienced crawfishermen agree that large gizzard shad, cut into chunks, is the best crawfish bait for traps. This bait, along with various types of fish heads and cut carp, is sometimes scarce during the fishing season. A few of the larger farmers have installed large freeze lockers for storing bait prior to the start of the fishing season. Bait is usually more available in late August and September than in later months. This saves labor and transportation costs in procuring bait during the December-March period.

Bait should be handled properly and kept as fresh as possible. A good rule of thumb is "handle bait as you would fish for the table."

Harvesting crawfish with traps and nets is tedious and expensive. The densely vegetated crawfish ponds do not lend themselves to methods such as seining or trawling. Research has produced no better harvesting methods than those presently used, although experiments with traps of a new design have produced promising results.

Compared to harvesting, constructing a pond and growing crawfish are relatively simple. For maximum yield a crawfish pond must be fished intensively throughout the season. There is usually a shortage of fishermen who will stay with one farmer for a full season. These fishermen sometime move to areas where wild crawfish crops have appeared. They may move to higher producing ponds. During the early part of the season, crawfishing is slowed down by cold weather and fishermen are reluctant to run their traps frequently. This presents a problem to the farmer who has a contract to deliver crawfish to a buyer at specific times.

A rice farmer may employ farm labor and get his crawfish harvested for as little as 6 cents a pound. His field is easily fished and the fishing usually occurs between crops when the farm laborer needs the extra income.

The non-rice farmers, who usually employ professional crawfishermen, pay the fishermen about ½ of the current market price for live crawfish. This represents the greatest single expenditure in the operation.

Some farmers harvest their crop by opening their ponds to the public. This can be done by charging a set fee and allowing an unlimited amount of crawfish to each individual. Another method involves weighing the crawfish caught and charging the individual less than the current market price per pound of live crawfish. A third method is, set fee can be charged, along with a smaller charge per pound of crawfish caught. The straight "per pound" method appears to be the most profitable.

The success of a crawfish operation depends to a large degree on the same factors which determine the success of any business venture. It is still erroneously believed that a levee can be built around any area and a high yield of crawfish obtained with little expense or effort. Poor site selection, short cuts in construction and lack of adequate fresh water will produce an unsatisfactory operation. Procedures must be followed and markets must be aggressively sought. The most successful operations are those with at least one good "salesman."

Control of Fish

After the harvesting season, the pond is drained. Low spots or inside borrow pits may still hold water after draining and will usually contain fish. Green sunfish (choupique perch), bowfin (choupique) (grinnel) and bullheads (pollywogs) (black catfish) are common species that will survive in these potholes until reflooding time. Rotenone should be applied to these potholes at a rate of 2-3 parts per million. Rotenone at 5 parts per million will kill some young crawfish. A fisheries biologist should be contacted for advice in this treatment.

Screening inflow pipes has also been tried as a fish control measure. The 12-24 inch pumps employed on most ponds move great volumes of water and make screening difficult. A fairly effective and sturdy screen is a cylinder of 1 inch weldwire about 3 feet in diameter and 12 feet long. This screen allows very small fish to enter the pond. Smaller mesh screens, however, will stop up quickly and require constant cleaning.

Many successful crawfish farmers reason that most of the large fish are killed by the pump impellors and do not screen inflow pipes. Rotenone and draining are their only fish control measures.

It is recommended that a screen be placed over the inflow pipe and checked periodically for the first several days. In this way, the farmer can determine the number and types of fish entering the pond. If large numbers of sunfish, catfish, bowfin and the like are present, a screen should be employed.

Summary of Procedures

Procedure	*Approximate Date*
Construction and Flooding (new pond)	By May 15th
Stocking (new pond)	June 1-30
Draining	June 15-July 15 (begin two weeks after stocking) (old ponds by June 30)
Fish Control	July 15-August 1
Improvement and vegetation control or planting	As soon as possible after bulk of pond dry June 30-August 15
Flooding	By October 15-No earlier than October 1
Harvest	Old Pond—November 25-June 30, continuously during mild winter, intermittently during severe winter. New Pond—December 20-June 30, if hatch successful.

CRAWFISH FARMING ECONOMICS

General

Early estimates of the potential profits of crawfish farming have been overly optimistic. Some of these estimates predicted the annual production of 1,000 pounds of crawfish per acre and profits of $90-$100 per acre. Many crawfish farms have failed to approach these figures. An improperly located or poorly constructed pond has little chance of producing more than 100-200 pounds per acre. Well constructed and properly managed ponds, however, commonly produce 500-700 pounds per acre.

The manner in which the crawfish are disposed of determines the net profit per acre to a large degree. The general location of the pond is also important. Crawfish farmers located well away from the Atchafalaya Basin generally have local markets and receive consistently higher prices for their crawfish.

There is no set, or average type of crawfish operation. They range in size from 20-40 acre "one-family" operations to 400-700 acre ponds employing as many as 15 fishermen. Some farmers sell live crawfish to dealers at wholesale prices; others sell to individuals or restaurants at retail prices. Many farmers sell only live crawfish while others may sell live crawfish, boiled crawfish and peeled tails.

The discussion on investment returns below is based on a broad general average of all types of crawfish operations. The prospective crawfish farmer is strongly advised to take a careful look at his particular locality before attempting to start an operation.

Construction Costs

The cost per acre for constructing suitable levees and drains on 12 ponds of 100-300 acres varied from $42 to $67 per acre, according to the owners. This did not include ponds constructed by rice farmers and others who used farm-owned equipment.

It has been mentioned that clearing of trees and underbrush within the levees will increase costs. This ranges from about $30 per acre for thinly wooded areas to $100 per acre for thickly wooded areas. Complete clearing of thickly wooded areas more than doubles the cost of pond construction. A partial clearing of strips 40-60 feet wide will allow the growth of some vegetation and provide better access for fishermen. This, in 25% of the pond area, can be accomplished for a cost of $10-$25 per acre of total area.

Pumping Equipment

Power take-offs from used farm tractors are commonly used to operate low lift water pumps in crawfish ponds. Recently, however, many farmers have installed stationary engines, new or rebuilt, which run on LP gas, diesel or butane. A dependable engine is a necessity for assuring adequate water for flooding or "flushing out" ponds at the proper time. For ponds of 100 acres or more, the cost of pumping equipment is roughly $10 per acre.

The above figures deal with operations which pump from "free water" streams or canals. Rice farmers who propose to raise crawfish will be able to compute water costs from prior rice farming activities.

An increasing number of crawfish farmers are installing 6 to 12 inch bore deep wells for flooding. The costs of these wells are variable with water table depth and size of bore. Wells have several advantages: they decrease problems of pollution, over-fertilization and predation by fish.

Annual Gross Returns

Prices for live crawfish have averaged an increase of about 5 cents per pound per year for the past three years. The wholesale price for live crawfish averaged more than 30 cents per pound during the 1969-70 season due to a short crop. Retail prices averaged 35 cents or slightly more. The per-pound average for peeled crawfish tails will be approximately $2.70.

It is expected that the wholesale price for live crawfish will average or exceed 30 cents per pound during future seasons. Good management procedures should bring the average production per acre to 500 pounds. This would put the average gross per acre at $150 for operators who sell at wholesale prices. The gross for operators selling at retail prices would be $175. Peeled crawfish tails average about 16 pounds per 100 pounds of live crawfish. At $2.70 per pound the gross per acre increases to $216.00.

Annual Net Returns

Harvesting costs average about ⅓ of the gross. This varies from ¼ of the gross where farm labor is available to about ½ of the gross where professional fishermen are employed. Pumping costs, to include maintenance and wear-and-tear on equipment, will average about $12 per acre.

Vegetation control, cost of traps, repair of levees, etc. average about $8 per acre.

The average net per acre for all types of operations, derived from the above figures, would be about $80 per acre at wholesale prices and $105 per acre at retail prices.

For an operation which deals in peeled tails only, the net per acre increases to about $131.

Due to the extreme variability of crawfish operations a more accurate rundown on crawfish farming operations is not possible. During the 1969-70 season many ponds grossed more than $300 per acre. These were well managed, open, non-ricefield ponds. Many wooded ponds and poorly managed ponds did not gross $100 per acre. Exceptions were first year wooded ponds where large populations of crawfish were already present—these ponds will not produce consistently over a long period.

The following steps should be taken before constructing a crawfish pond:

1. Contact the writer or the Louisiana Department of Agriculture for a preliminary survey of the pond site. A thorough study of this pamphlet before the survey should be helpful.
2. Have estimates made of construction costs. Soil Conservation Service personnel, dirt contractors, well contractors, etc. should be consulted.
3. Learn facts about the crawfish market in the immediate area.
4. Line up fishermen for the operation.
5. Consider future expansion problems. Several successful farmers want to expand, but did not include this in their planning. Land, labor and water supply should be considered.

Crawfish Quality

Experienced buyers will not handle substantial amounts of poor quality crawfish. Crawfish from ponds which do not have an adequate amount of green vegetation produce crawfish which have brown or black "fat" or liver. Usually the tails of these crawfish are not fully filled out. High quality crawfish are those greater than 3-½ inches long from tip of tail to tip of head, 15-25 per pound, with bright yellow fat. These will produce 15-18 pounds of tail meat per 100 pounds of live crawfish.

LIST OF AVAILABLE TECHNICAL PERSONNEL

District I, P. O. Box 915, Minden, La. 71055—Ph. 377-3575 (318)
  Charles Hoenke, Fisheries Biologist
  E. W. Goodwin, Waste Disposal Investigator—Ph. 377-5892 (318) Minden, La.

District II, P. O. Box 4004, Ouachita Station, Monroe, La. 71201—Ph. 325-8267 (318)
  Bobby Walker or Janice S. Hughes, Fisheries Biologist

District III, P. O. Box 278, Tioga, La. 71477—Ph. 442-1384 (318)
  Sammy Stokes, Fisheries Biologist
  Darrel B. Reed, Waste Disposal Investigator—Ph. 639-2364 (318) Oberlin, La.

District IV, P. O. Box 426, Ferriday, La. 71334—Ph. 757-4571 (318)
  Arthur M. Williams, Fisheries Biologist

District V, 1213 North Lakeshore Drive, Lake Charles, La.—Ph. 436-3661 (318)
  Dudley Clay Carver, Fisheries Biologist
  Larry Racca, Waste Disposal Investigator, Ph. 433-7278 Lake Charles, La.
  Lubert Reed, Waste Disposal Investigator, 799-2532 (318) Iota, La.

District VI, P. O. Box 593, Opelousas, Louisiana 70570
  Cecil G. LaCaze, Crawfish Biologist
  Kenneth E. Lantz, Fisheries Biologist
  R. L. Bourriague, Waste Disposal Investigator, Ph. 235-2250 (318) Lafayette, La.

District VII, P. O. Box 14526, Southeast Station, Baton Rouge, La. 70808—Ph. 389-5134 (504)
  Gladney G. Davidson, Fisheries Biologist
  Jimmy Dixon, Waste Disposal Investigator, Ph. 698-2380, Livingston, La.
  Albert E. Howard, Waste Disposal Investigator, Ph. 732-3900 (504) Bogalusa, La.

District VIII, 400 Royal Street, New Orleans, La. 70130—Ph. 731-5326 (504)
  Howard Rogillio, Fisheries Biologist
  Edward Lewing, Waste Disposal Investigator

CRAWFISH CLEANING AND PACKING PLANTS

Acadia

		Bd. of Health Permit No.
Breaux, LeRoy	Route 2, Box 28, Rayne	LA-127
John's Crayfish Plant	Route 2, Box 244, Eunice	LA-211

Assumption

Breaux & Daigle Fish Co.	Belle Rose P.O., Pierre Part	LA-136
Cavalier's Seafood Co.	Box 81, Belle Rose	LA-7
Oaks Seafood	Belle Rose P.O., Pierre Part	LA-271

Avoyelles

Lake Pearl Seafood Co.	Hessmer	LA-258

Evangeline

Mamou Sea Foods & Crawfish and Packing Plant	1209 Railroad Ave., Mamou	LA-142

Iberia

New Iberia Crawfish Cleaning Plant	1229 Jane St., New Iberia	LA-215

Iberville

Berthelot, Felician J.	Route 2, Box 572-A, Plaquemine	LA-216
Hebert, Alden J.	Bayou Pigeon, Plaquemine	LA-233
Intracoastal Packing Co.	Star Route, 522, Plaquemine	LA-72
Leonard's Crawfish Plant	Route 2, Box 506, Plaquemine	LA-209

Rapides

Glorioso's Market	603 Monroe Street, Alexandria	LA-239

St. Landry

Lanclos Crayfish Farm	Route 2, Box 81, Bunkie	LA-133
St. Landry Crawfish Center	Route 2, Box 41, Opelousas	LA-104

St. Martin

		Bd. Of Health Permit No.
Amy Fisheries	Henderson Station, Breaux Bridge	LA-121
Bonanza Crayfish Farms Inc.	Henderson Station, Breaux Bridge	LA-263
Catahoula Crawfish Plant	Route 2, Box 305, St. Martinville	LA-75
Daigle, Alfred Crawfish Plant	Route 1, Box 370, Breaux Bridge	LA-183
Don's Crayfish Ranch	Henderson Station, Breaux Bridge	LA-177
Dupuis Seafood, Essie	917 Grand Point Ave., Breaux Bridge	LA-76
Guidry's Seafoods	P. O. Box 15, Cecelia	LA-126
Hardy Fisheries	Arnaudville	LA-54
Henderson Seafood	P. O. Box 538, Breaux Bridge	LA-140
Latiolais, Sidney	Rt. II, Box 360, St. Martinville	LA-291
Monte's Place	Rt. 1, Box 371, Breaux Bridge	LA-59
Mulatte's Seafoods	916 Berard St., Breaux Bridge	LA-204
Naquin's Seafoods	Rt. 2, Box 350, Breaux Bridge	LA-265
Pak-A-Sak Crawfish & Fish House	Henderson Station, Breaux Bridge	LA-63
Robichaux, Duclide & Son	Rt. 2, Box 327, St. Martinville	LA-293
Robin, Howard Seafoods	Rt. 2, Box 292, St. Martinville	LA-129
Robin's Seafoods	542 Henderson Sta., Breaux Bridge	LA-28
Scrantz Seafoods	Rt. 2, Box 186, Breaux Bridge	LA-225
Sidney, Chex	Rt. 2, Box 228, St. Martinville	LA-137

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